Name: KEY

AP Physics [redacted] 1 Math Competency Review

The following test is designed to allow you, the student, to determine if your math skills are adequate for the AP Physics [redacted] 1 course. Be aware that this course is NOT calculus based.
Thus, your math skills need to include Algebra, Geometry and some simple Trigonometry, applied to right angle triangles.

You will have a quiz tomorrow over this content.

1) $A = 5$ $B = 7$ $C = -2$

$\boxed{X = 10}$

Calculate the following expression: $X = A + B + C$

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2) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = C - B - A$

$X = 5 - (7) - (-2)$ $\boxed{X = 0}$

$X = 5 - 7 + 2$

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3) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = 8 \cdot (B - C) + 3 \cdot A$

$X = 8(9) + 15$

$X = 8(7 - (-2)) + 3(5)$ $\boxed{X = 87}$

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4) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = 8 \cdot B - C + 3 \cdot A$

$X = (8 \cdot 7) - (-2) + (3 \cdot 5)$

$X = 56 + 2 + 15$

1 $\boxed{X = 73}$

5) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = \frac{8 \cdot B}{3 \cdot A} - C$

$X = \left[\frac{(8 \cdot 7)}{(3 \cdot 5)}\right] - (-2)$

$X = \frac{56}{15} + 2$

$X = \frac{56}{15} + \frac{30}{15} = \boxed{\frac{86}{15}}$

$\boxed{5.7\overline{3}}$

6) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = \frac{8 \cdot (B - C)}{3 \cdot A}$

$X = \frac{8(7-(-2))}{3 \cdot 5}$

$X = \boxed{\frac{72}{15}}$ or $\boxed{4.8}$

7) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = 8 \cdot B - \frac{C}{3 \cdot A}$

$X = (8 \cdot 7) - \left(\frac{-2}{3 \cdot 5}\right)$

$X = 56 - \left(\frac{-2}{15}\right)$

$\boxed{X = 56.13}$ $X = \frac{840}{15} + \frac{30}{15} = \boxed{\frac{870}{15}}$

8) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = (8 \cdot B)^2 + C^2 - 3 \cdot A$

$X = (8 \cdot 7)^2 + (-2)^2 - 15$ $\boxed{X = 3125}$

9) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = \frac{1}{\frac{1}{8 \cdot B^2} - \frac{1}{C^2} + \frac{-1}{3 \cdot A}}$ $= \frac{1}{\frac{1}{(8)(7)^2} - \frac{1}{(-2)^2} + \frac{-1}{(3)(5)}}$

$\frac{1}{\frac{1}{392} - \frac{1}{4} - \frac{1}{15}}$ $\boxed{X = -3.18}$

10) $A = 5$ $B = 7$ $C = -2$

Calculate the following expression: $X = \frac{1}{\frac{1}{\left[8 \cdot (B - C)^2\right]^{\left(\frac{1}{2}\right)}} - \frac{1}{(3 \cdot A)^{\left(\frac{-1}{3}\right)}}}$

$\frac{1}{\frac{1}{\sqrt{8(7-(-2))^2}} - \frac{1}{\frac{1}{\sqrt[3]{3(5)}}}}$ $\rightarrow$ $\frac{1}{\frac{1}{\sqrt{5184}} - \frac{1}{\frac{1}{\sqrt[3]{15}}}}$ $\rightarrow$ $\frac{1}{\frac{1}{\sqrt{5184}} - \sqrt[3]{15}}$

2 $\frac{1}{-2.452}$ $\rightarrow$ $\boxed{X = -0.41}$

11) $a = 9$ $\quad x = 56$

Solve the following for the unknown: $x = \frac{a}{b}$

$b = \frac{a}{x} = \boxed{\frac{9}{56}}$

12) $d = 17$ $\quad y = 75$

Solve the following for the unknown: $y = \frac{c}{d}$

$c = yd$

$c = \boxed{1275}$

13) $e = 12$ $\quad z = 5$

Solve the following for the unknown: $z = e \cdot f$

$f = \frac{z}{e} = \boxed{\frac{5}{12}}$

14) $g = 3$ $\quad w = 101$

Solve the following for the unknown: $w = g \cdot h$

$h = \frac{w}{g} = \boxed{\frac{101}{3}}$

15) $k = 5$ $\quad l = -9$

Solve the following for the unknown: $k \cdot t - l \cdot t^2 = 0$

$k\cancel{t} = lt^2$ $\quad k = lt$ $\quad t = \frac{k}{l} = \boxed{\frac{5}{-9}}$

16) Solve the following for the unknown: $12 \cdot \cancel{r} + 3 \cdot r^2 = r^2 - 4 \cdot \cancel{r}$

$12 + 3r = r - 4$

$12 + 4 = r - 3r$

$16 = r(1-3)$

$\boxed{r = -8}$

17) Solve the following for the unknown: $(3+s) \cdot 4 = \frac{(7-s) \cdot 2}{3}$

$12 + 4s = \frac{14 - 2s}{3}$ / $36 + 12s = 14 - 2s$ / $12s + 2s = 14 - 36$

$14s = -22$

$\boxed{s = -\frac{22}{14}}$

18) Solve the following for the unknown: $\frac{1}{2 \cdot T} = 3 \cdot T + 6 \cdot (1 - T)$

$\frac{1}{2T} = 3T + (6 - 6T)$

$\frac{1}{2T} = 3T + 6 - 6T$

$\frac{1}{2T} = -3T + 6$

$\frac{1}{2T} + 3T = 6$

$\frac{1}{2T} + \frac{2T(3T)}{2T} = 6$

$\frac{1}{2T} + \frac{6T^2}{2T} = 6$

3 $\frac{6T^2 + 1}{2T} = 6$

Quadratic

$0 = 6T^2 - 12T + 1$

$\boxed{T_1 = 1.91 \quad T_2 = 0.09}$

$\boxed{\frac{21}{2}\left(\sqrt{\frac{126}{84}}\right)=Q}$ $3\left(\sqrt{\frac{126}{84}}\right)=\frac{2Q}{7}$ $\boxed{S=1.22}$ $\boxed{\sqrt{\frac{126}{84}}=S}$

$\boxed{Q=12.81}$

19) Solve the following for the unknowns: $3\cdot S = \frac{2\cdot Q}{7}$ $\qquad 21 = 4\cdot Q\cdot\frac{S}{3}$

$21S = 2Q$

$Q = \frac{21S}{2}$

$21 = 4\left(\frac{21S}{2}\right)\frac{S}{3}$

$21 = \frac{84S^2}{6}$

20) Solve the following for the unknowns: $\frac{R}{5} = 3\cdot P$ $\qquad 7\cdot R - 3\cdot P = \frac{12}{2\cdot P + 7}$

$R = 15P$

$7(15P) - 3P = \frac{12}{2P+7}$

$105P - 3P = \frac{12}{2P+7}$

$(2P+7)102P = 12$

$204P^2 + 714P = 12$

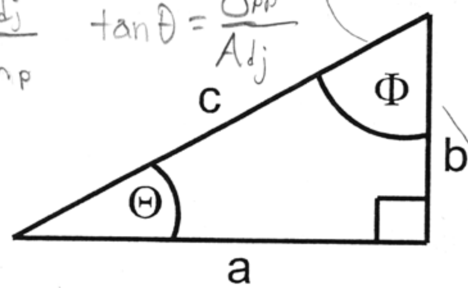
$\emptyset = 204P^2 + 714P - 12$

Quadratic! $\boxed{P_1 = 0.017 \quad P_2 = -3.52}$

The following questions refer to the following diagram:

SOH CAH TOA

$\sin\theta = \frac{Opp}{Hyp}$ $\qquad \cos\theta = \frac{Adj}{Hyp}$ $\qquad \tan\theta = \frac{Opp}{Adj}$



21) How would you calculate the following: $sin(\Theta)$

b = opposite
a = adjacent
c = hypotenuse

SOH $\quad \sin\theta = \frac{opp}{hyp}$

$\boxed{\sin\theta = \frac{b}{c}}$

22) How would you calculate the following: $cos(\Theta)$

$\boxed{\cos\theta = \frac{a}{c}}$

23) How would you calculate the following: $tan(\Theta)$

$\boxed{\tan\theta = \frac{b}{a}}$

24) How would you calculate the following: $sin(\Phi)$

a = opposite
b = adjacent
c = hypotenuse

$\boxed{\sin\Phi = \frac{a}{c}}$

25) How would you calculate the following: $cos(\Phi)$

$\boxed{\cos\Phi = \frac{b}{c}}$

26) How would you calculate the following: $tan(\Phi)$

$\boxed{\tan\Phi = \frac{a}{b}}$

look at triangle below!

27) $a = 5 \cdot in$ $\Phi = 38 \cdot deg$ How long is the following side? $b = ?$ (in)

TOA $\tan\Phi = \frac{a}{b}$ $\tan(38^\circ) = \frac{5in}{b}$ $b = \frac{5in}{\tan(38^\circ)} = \boxed{6.40in}$

28) $b = 7 \cdot mi$ $\Phi = 17 \cdot deg$ How long is the following side? $c = ?$ (mi)

CAH $\cos\Phi = \frac{b}{c}$ $c = \frac{b}{\cos\Phi} = \frac{7mi}{\cos(17^\circ)} = \boxed{7.32mi}$

29) $c = 12 \cdot ft$ $\Theta = 65 \cdot deg$ How long is the following side? $a = ?$ (ft)

CAH $\cos\theta = \frac{a}{c}$ $a = c\cos\theta$ $a = 12ft\cos(65^\circ) = \boxed{5.07ft}$

30) $b = 3 \cdot cm$ $\Theta = 83 \cdot deg$ How long is the following side? $c = ?$ (cm)

SOH $\sin\theta = \frac{b}{c}$ $c = \frac{b}{\sin\theta} = \frac{3cm}{\sin(83^\circ)} = 3.02cm$

31) $a = 9 \cdot in$ $b = 1 \cdot ft$ How long is the following side? $c = ?$ (ft)

$a = \frac{9in}{} \Big| \frac{1ft}{12in} = 0.75ft$ $c^2 = a^2 + b^2$ pythagorean theorem. $c = \sqrt{a^2 + b^2}$ $c = \sqrt{(0.75ft)^2 + (1ft)^2}$ $\boxed{c = 1.25ft}$

32) $c = 18 \cdot mi$ $b = 20000 \cdot ft$ How long is the following side? $a = ?$ (mi)

$\frac{20000ft}{} \Big| \frac{1mi}{5{,}280ft} = 3.79mi$ $a^2 = c^2 - b^2$ $a = \sqrt{c^2 - b^2}$ $a = \sqrt{(18mi)^2 - (3.79mi)^2}$ $\boxed{a = 17.60mi}$

33) $a = 32 \cdot ft$ $b = 144 \cdot in$ What is the following angle? $\Phi = ?$ (deg)

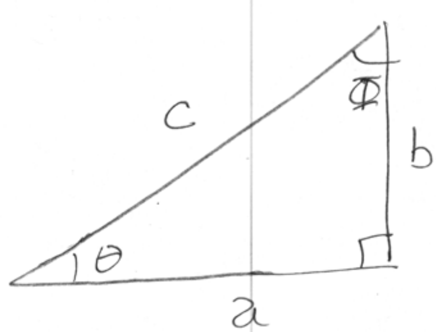
TOA $\frac{144in}{} \Big| \frac{1ft}{12in} = 12ft$ $\tan\Phi = \frac{a}{b}$ $\Phi = \tan^{-1}\left(\frac{32ft}{12ft}\right)$ $\boxed{\Phi = 69.4^\circ}$

34) $c = 100 \cdot mi$ $a = 100000 \cdot yd$ What is the following angle? $\Theta = ?$ (rad)

$\frac{100{,}000yd}{} \Big| \frac{1mi}{1{,}760yd} = 56.82mi$

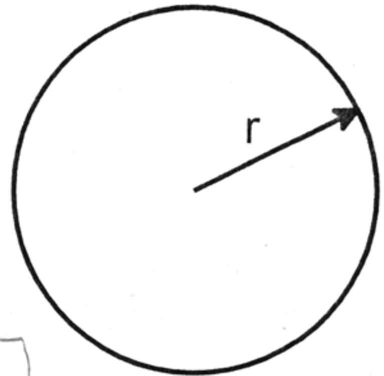
CAH $\cos\theta = \frac{a}{c}$ $\theta = \cos^{-1}\left(\frac{56.82}{100}\right)$

$\boxed{\theta = 55.4^\circ}$



35) What is the circumference of the circle?

$r = 3 \cdot cm$



$C = 2\pi r$

$C = 2\pi(3cm)$

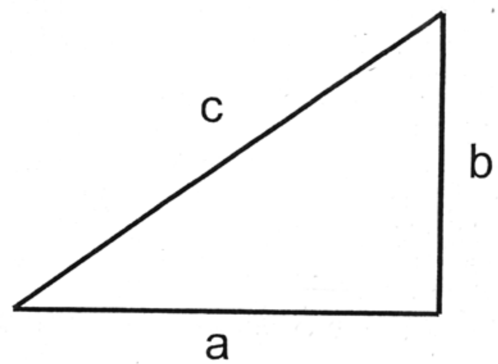
$C = \boxed{18.85\,cm \text{ or } 6\pi\,cm}$

36) What is the area of the above circle, in square centimeters?

$A = \pi r^2$ $\quad A = \pi \cdot (3cm)^2$ $\quad A = \boxed{28.3\,cm^2 \text{ or } 9\pi\,cm^2}$

37) What is the area of the triangle, in square feet?

$a = 3 \cdot ft$ $\qquad b = 8 \cdot ft$



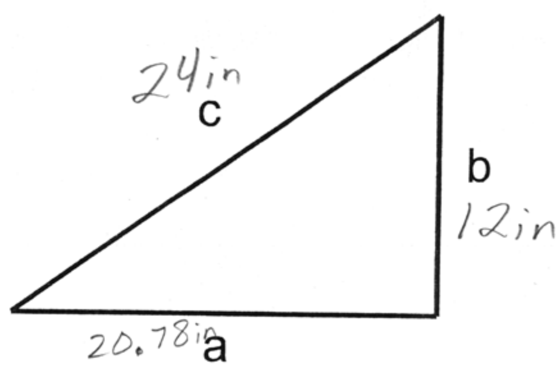
$A = \frac{1}{2}bh$

$A = \frac{1}{2}(3ft)(8ft) = \boxed{12ft^2}$

38) What is the area of the triangle in square inches?

$b = 12 \cdot in$ $\qquad c = 2 \cdot ft$

$c = \frac{2ft \mid 12in}{\mid 1ft} = 24in$



$A = \frac{1}{2}bh$

$A = \frac{1}{2}(20.78in)(12in)$

$\boxed{A = 124.68\,in^2}$

$a^2 = c^2 - b^2$

$a = \sqrt{(24)^2 - (12)^2}$

$a = \sqrt{432}$

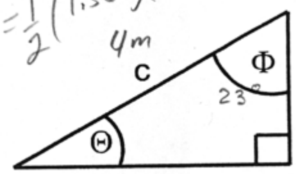
$a = 20.78in$

$A = \frac{1}{2}bh$

$A = \frac{1}{2}(1.56m)(3.68m)$

$\boxed{A = 2.87 m^2}$

39) What is the area of the triangle, in units of square meters?



$c = 4 \cdot m$ $\Phi = 23 \cdot deg$

$\cos\Phi = \frac{b}{c}$

$b = c \cdot \cos\Phi$

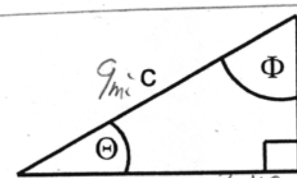
$b = 4\cos(23°)$

$b = 3.68m$

$\sin\Phi = \frac{a}{c}$ $a = 4m\sin(23°)$

$a = c\sin\Phi$ $a = 1.56m$

40) What is the area of the triangle, in units of square miles?



$b = 9 \cdot mi$ $\Theta = 1.2 \cdot \cancel{rad} \left| \frac{360°}{2\pi \cancel{rad}} \right. = 68.8°$

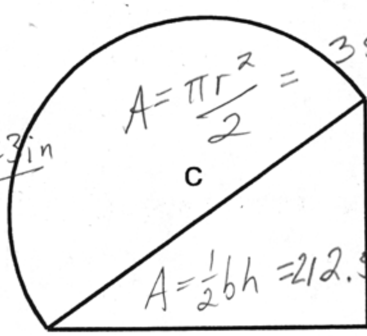
$\tan\Theta = \frac{b}{a}$

$a = \frac{b}{\tan\Theta} = \frac{9mi}{\tan(68.8°)} = 3.49mi$

$A = \frac{1}{2}bh = \frac{1}{2}(3.49)(9) = 15.7 mi^2$

41) What is the area of the following shape, in units of square inches?

$a = 17 \cdot in$ $b = 25 \cdot in$



$\boxed{A_{tot} = 571.6 in^2}$

$c^2 = a^2 + b^2$

$c = \sqrt{a^2 + b^2}$

$c = \sqrt{17^2 + 25^2}$

$c = 30.23 in$

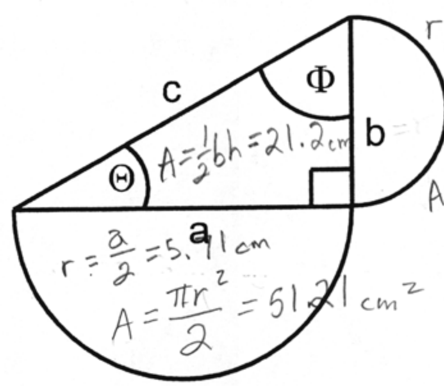
$D = 2r$

$r = \frac{D}{2} = \frac{30.23in}{2}$

$r = 15.12 in$

42) What is the area of the following shape, in units of square centimeters?

$c = 12 \cdot cm$ $\Theta = 18 \cdot deg$



$\cos\Theta = \frac{a}{c}$

$a = c(\cos\Theta)$

$a = 12cm\cos 18°$

$a = 11.41m$

$\sin\Theta = \frac{b}{c}$

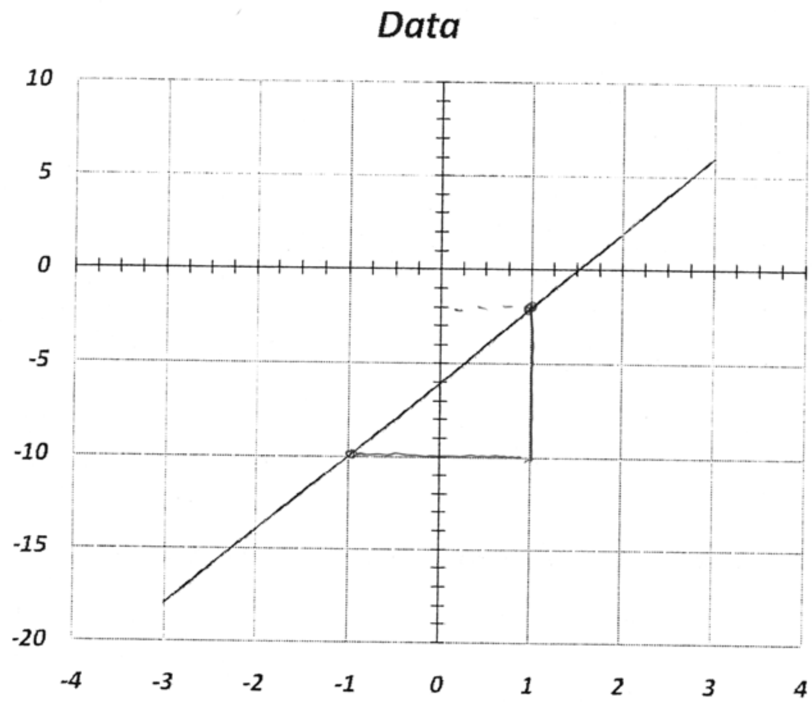
$b = c \cdot \sin\Theta$

$b = 12\sin(18°)$

$b = 3.71cm$

$A_{tot} = 77.84 cm^2$

The following questions refer to the graph of the red line shown below:



43) What is the slope of the graphed line?

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-2-(-10)}{1-(-1)} = \frac{8}{2} = \boxed{4}$$

44) What is the y-intercept of the graphed line?

$b = -6$

45) What is the equation of the graphed line in the "slope-intercept" format?

$y = mx + b$ $\quad$ $y = 4x - 6$

46) What X value correlates to a Y value of -13?

$$\frac{y+6}{4} = x = \frac{-13+6}{4} \quad \boxed{x = -1.75}$$

47) What Y value correlates to an X value of 1.75?

$$y = 4(1.75) - 6 \quad \boxed{y = 1}$$

48) What X value correlates to a Y value of 15, if the line were extended?

$$x = \frac{y+6}{4} = \frac{15+6}{4} \quad \boxed{x = 5.25}$$

(8)

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Physics Skills – Determining Relationships from Graphs

Data collected in the lab is often plotted and analyzed graphically. When the curve of the graph is a straight line, the equation for the relationship between the variables y and x is as follows: **y = mx + b** where m is the slope of the line and y is the y intercept.

When the curve of the graph is not a straight line, you will need to identify the type of curve. Often it will fit into the categories of root curves, power curves (parabolic), or inverse curves (hyperbolic).

To verify which of these curves you have, the data are systematically manipulated until the graph of the data yields a straight line. The equation for the straight line can then be written and you will have obtained the relationship between the variables.

If your graph looks like a **power curve (parabola)**, you would expect the equation to be $\mathbf{y = kx^2}$. To see if you can "straighten" the curve, calculate the values of x^2. Then plot the values of y versus x^2. A simple example is given below. Column y and t are the experimental data. Column t^2 contains the manipulated data. As you can see, the graph of y versus t^2 is a straight line and has a slope of 1.0 m/s^2. The equation of the line is $y = (1\ m/s^2)(t^2)$. This equation corresponds to the generic equation for a straight line, **y = mx + b**.

y (cm)	t (s)	t^2 (s^2)
0.0	0.0	0.0
1.0	1.0	1.0
4.0	2.0	4.0
9.0	3.0	9.0
16.0	4.0	16.0

position versus time

position versus (time)^2

If your graph looks like a **root curve**, you would expect the equation to be $\mathbf{y = k\sqrt{x}}$ or $\mathbf{y = kx^{1/2}}$. To see if you can "straighten" the curve, calculate the values of $\sqrt{x}$. Then plot the values of y versus $\sqrt{x}$.

If your graph looks like an **inverse (hyperbolic) curve**, you would expect the equation to be **y = k/x**. To see if you can "straighten" the curve, calculate the values of 1/x. Then plot the values of y versus 1/x.

If these manipulations do not straighten the curve, you are dealing with a more complex relationship between the variables of your graph.

Do this → For each of the three sets of data given, straighten the curve and write the equation of the line. Plot the data in the left hand column on the x axis. Plot the data in the right hand column on the y axis. Create a third, manipulated data column to the right of the right hand column (y axis) data. On each sheet of graph paper given below, plot the graph of your original data and the graph of your manipulated data. Write the correct formula for each set of data.

1.

time (s)	distance (cm)	time^2 (s^2)
3.8	0.63	14.44
5.1	1.17	26.01
6.0	1.68	36
7.3	2.39	53.29
8.1	2.97	65.61
9.1	3.44	82.81
9.2	3.74	84.64

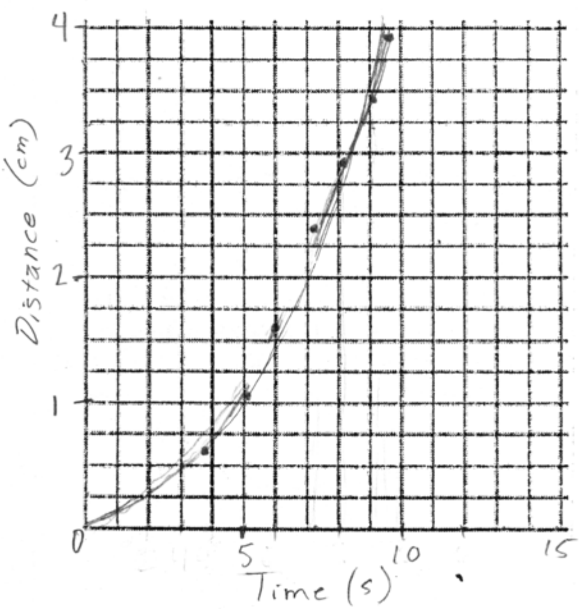
2.

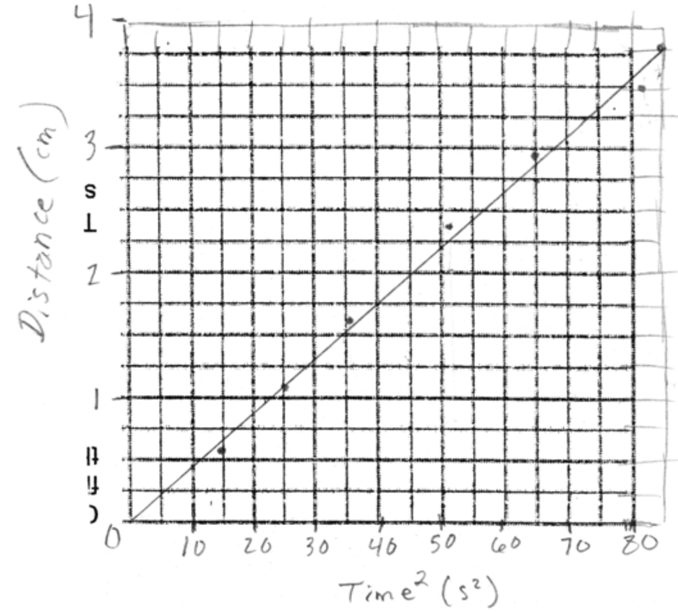
length (cm)	time (s)	$\sqrt{length}$ ($\sqrt{cm}$)
10.0	0.63	3.16
20.0	0.88	4.47
30.0	1.10	5.48
40.0	1.25	6.32
50.0	1.42	7.07
60.0	1.57	7.75
70.0	1.69	8.37
80.0	1.77	8.94

3.

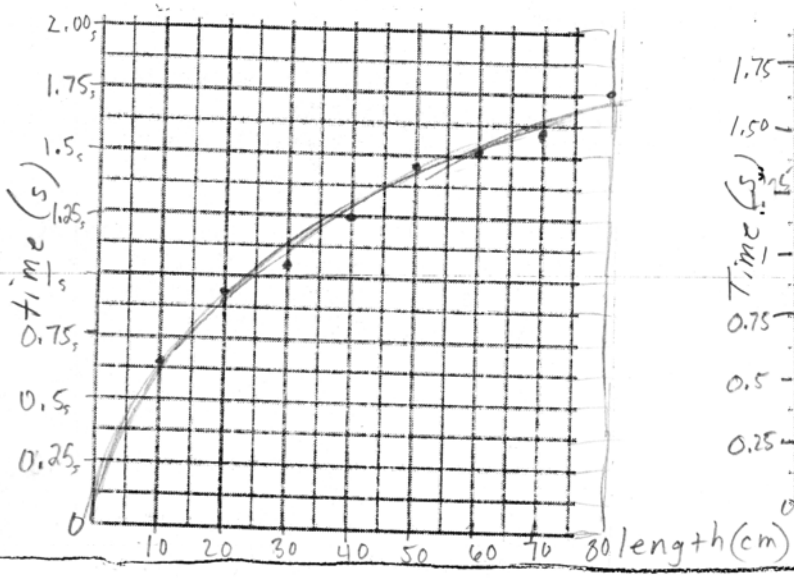
P(watts)	Area (cm^2)	$\frac{1}{P}$ ($\frac{1}{watts}$)
1.0	26.0	1
2.0	13.0	0.5
3.0	8.7	0.33
4.0	6.5	0.25
5.0	5.2	0.2
6.0	4.3	0.167
7.0	3.7	0.143
8.0	3.3	0.125

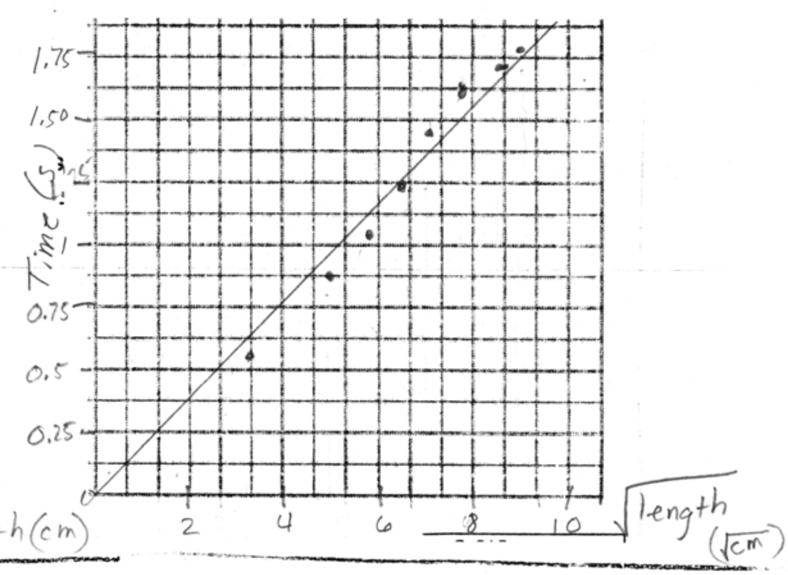
1.


Distance (cm)
Time (s)
0
1
2
3
4
5
10
15

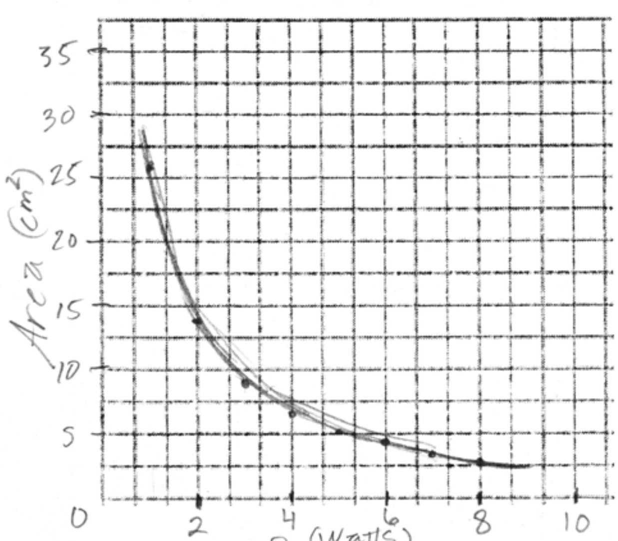

Distance (cm)
Time^2 (s^2)
0
1
2
3
4
10
20
30
40
50
60
70
80

2.

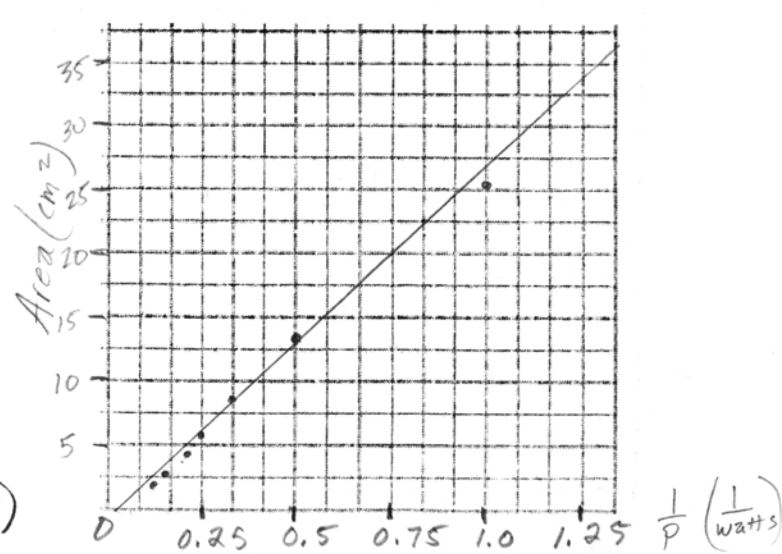

time (s)
length (cm)
0
0.25s
0.5s
0.75s
1s
1.25s
1.5s
1.75s
2.00s
10
20
30
40
50
60
70
80


Time (s)
$\sqrt{\text{length}}$ ($\sqrt{cm}$)
0.25
0.5
0.75
1
1.50
1.75
2
4
6
8
10

3.


Area (cm^2)
P (watts)
0
5
10
15
20
25
30
35
2
4
6
8
10

(10)


Area (cm^2)
$\frac{1}{P}$ $\left(\frac{1}{\text{watts}}\right)$
0
5
10
15
20
25
30
35
0.25
0.5
0.75
1.0
1.25

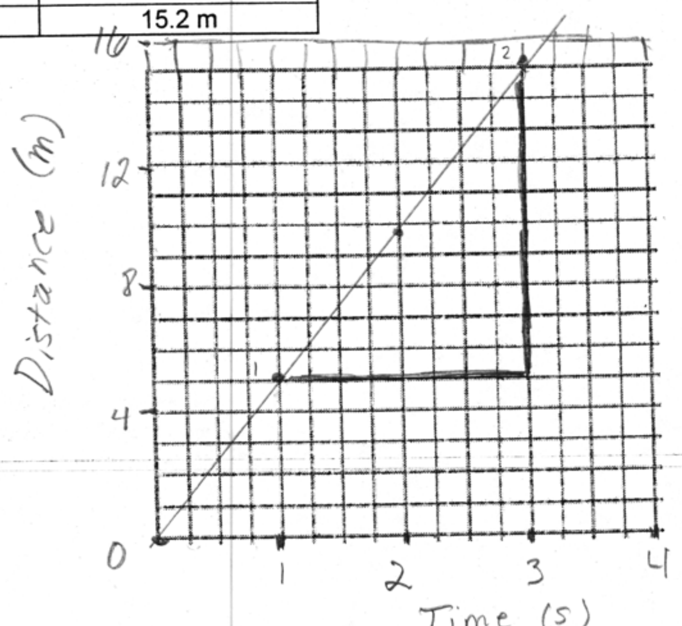
4. **Graphing and Graph Interpretation**

You should be familiar with graph construction (by hand and on a calculator). This is a topic that often appears on AP exams and is an easy way to score points on any assignment.

Note: When you are told to graph Apples vs. Oranges, the first thing goes on the y-axis. The second thing is on the x-axis.

Fill in the following table and plot the points on the grid below as distance versus time. Be sure to correctly label the graph (axes labels, including units, and title)

Time, *t* (s)	**Distance, *d* (m)**
0.0	0 m
1.0	5.1 m
2.0	9.9 m
3.0	15.2 m



Draw the best fit line through your data points. Use a graphing calculator to plot the graph. Record the equation of the best-fit line. What is the slope of the line that you plotted (with correct units)?

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{15 - 5}{3 - 1} = \frac{10}{2} = \boxed{5\ m/s}$$

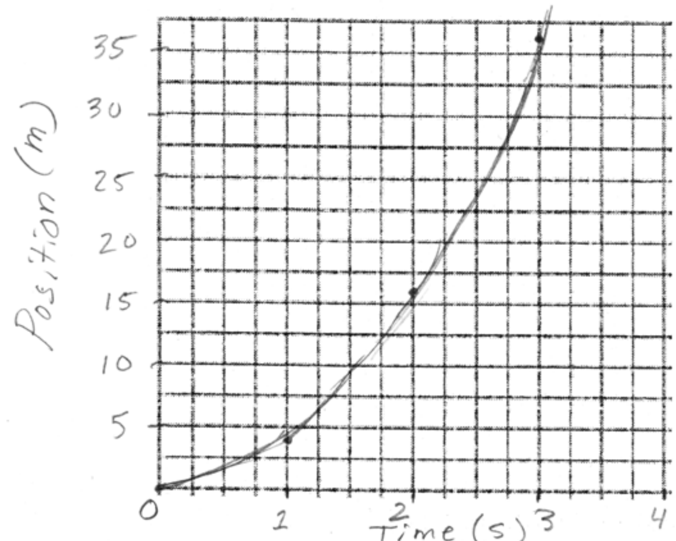
$y = mx + b$

$\boxed{y = 5x}$

$y = 5x + \emptyset$

5\. Plot position vs. time on the axes below.

Time	**Position**
0.0 s	0.0 m
1.0 s	4.1 m
2.0 s	15.8 m
3.0 s	36.2 m



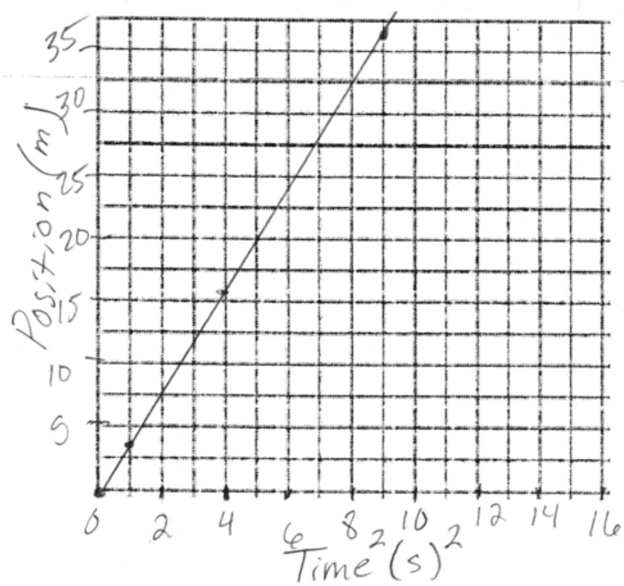
On your graphing calculator, create this plot and find the equation of the best fit curve. Record this best-fit equation below.

$y = 4.1x^2$

This graph has a changing slope. What does its slope represent?

changing velocity (acceleration)

This quadratic function can be "linearized" by squaring the time values, and plotting position vs. time squared. Try this with this data.



Find the equation of this best fit line on your graphing calculator. Record the equation of this best fit curve below.

$y = 4.1(x^2)$

$y = mx$

Find the slope of this graph (use correct units). What does it represent?

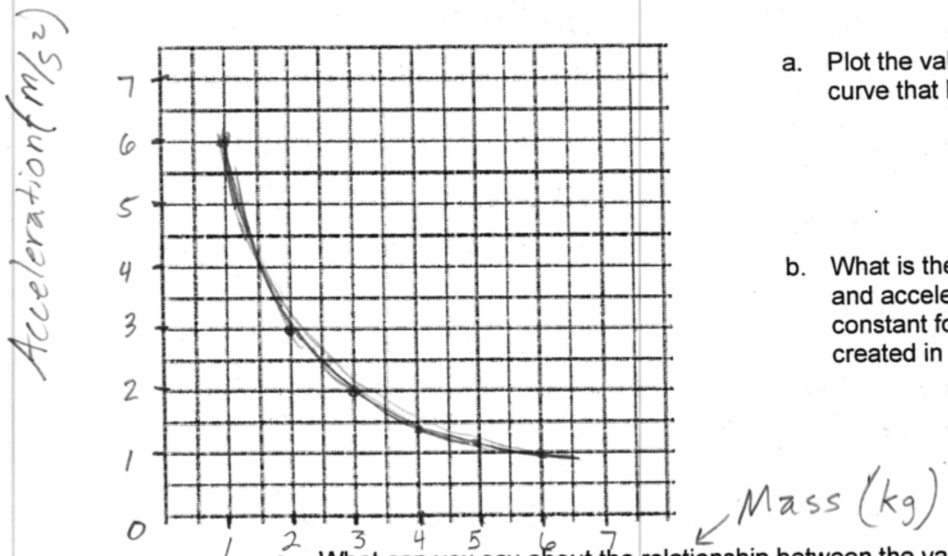
$\text{Slope} = \frac{\text{rise}}{\text{run}} = \frac{m}{s^2}$

$(\text{time})^2$	position
0	0
1	4.1
4	15.8
9	36.2

6. Other function types.

The results of a class experiment investigating the relationship between mass and acceleration are shown in the table below. The force applied to each mass was the same.

Mass (kg)	Acceleration (m/s²)
1.0	6.00
2.0	3.00
3.0	2.00
4.0	1.50
4.8	1.25
6.0	1.00



a. Plot the values given and draw the curve that best fits the points.

b. What is the relationship between mass and acceleration produced by a constant force (describe the plot you created in a.)?

inverse relationship

c. What can you say about the relationship between the values for mass and those for acceleration? Use a graphing calculator to find the equation of the best-fit curve to your data. Record it below.

$$y = m\frac{1}{x}$$

Algebra & Functions

A working knowledge of algebra is essential to success in physics. In AP Physics, there is more symbolic algebra, where symbols are used exclusively (no numbers!).

A **direct proportion** is a function whose graph is a non-horizontal line that passes through the origin. **y = kx ; k is the constant of proportionality**

A **linear** function has a graph that is a non-horizontal line. **y = mx + b; m is the slope of the line and b is the y-intercept.** A direct proportion is a special case of a linear function, where b = 0.

A **quadratic** function has a graph that is a parabola. When y is proportional to x^2, the graph goes through the origin and has a slope that increases as x increases. $\mathbf{y = ax^2 + bx + c}$

An **inverse** relation has a graph that is a hyperbola (in the first quadrant). When y is proportional to 1/x, the graph is asymptotic to the x and y axes. **y = k/x**

Identify the variable relationships.

7. *F = -kx, (F vs. x) This function is* linear "direct" *. K represents the* Slope *of the graph.*

8. *U = mgh, (U vs. h) This function is* linear *. mg represents the* Slope *of the graph*

9. *x = ½ at² (x vs. t) This function is* proportional to the square →(squared) *. Its graph will look like* parabolic *. If x is graphed vs. t² the slope will be* linear *.*

10. *a=F/m (a vs. m). This function is* inverse *. Its graph will look like* hyperbolic *.*

Solve the following. Show work for credit:

5. Solve for d_i $\quad \frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$

6. Solve for a. $\quad y = v_o t - \frac{1}{2}at^2$

7. Solve for θ_2 $\quad n_1 \sin\theta_1 = n_2 \sin\theta_2$

8. Solve for L $\quad T = 2\pi\sqrt{\frac{L}{g}}$

9. Solve for V_2 $\quad \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$